



THE COMMUNICATOR SURREY AMATEUR RADIO CLUB



Volume II

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Issue XXXV

VE7SAR

VE7RSC

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Surrey Amateur Radio Club

**ALWAYS MONITOR 147.36+ (110.9)
OR 443.775+ (110.9 in and out) IRLP 1463**

CLUB NET @ 8:00 P.M. Tuesday 147.36+ (110.9)

Thursday 144.250 USB 7:30 P.M.

CLUB MAILING ADDRESS : 239 -7156 121 St. Surrey, B.C. V3W 0J6

The next meeting of the Surrey Amateur Radio Club will be held on Wednesday February 4th 2009 at the Provincial Regional Emergency Operations Center (PREOC) located at 14275 96th Avenue Surrey V3T 4M5 - Enter off 96th Talk in on 147.36+ (110.9) 443.775+ (110.9)

Minutes for January 7, 2009 SAR Club meeting

1. Meeting was called to order at 7:30 pm January 7th, 2009. The meeting had been moved from our usual location at the PREOC to the ABC Restaurant 74/King George Hwy, due to their activation for heavy rainfall and flooding.

2. Health and Welfare:

Pat VE7PJS resigned this position due to personal commitments and Bob VE7FWZ has agreed to take this duty on. Thank you Pat for your work.

A report was given that 3 members were ill, one of them not expected to survive. (A subsequent note: Sadly Norm VA7NDM passed away Thursday

morning at approximately 5:00 am. He will be missed by the entire Surrey Club and Amateur Radio community.)

One of the members Heinz VA7AQ is recovering at home and would appreciate short visits or coffee.

3. Finance:

Lloyd VE7JLH reported \$4038.19 in the account with no further report.

4 Repeater:

A written report prepared by Steve VE7MAN was given. The 443 repeater now has an IRLP node working. The 220 repeater is waiting on the antenna.

5. A D-STAR Presentation was given by Sol Lancashire VA7SOL from Burnaby. An excellent evening of explanation with a PowerPoint presentation.

8. 50/50 draw (approx \$8.50) was won by ?????

Meeting closed at 09:00

The Prez Sez



Hello everyone
I hope you all had a safe Christmas and new years. SARC is kicking 2009 off with a bang, Jan

23rd we start our second nine week amateur radio course followed by a flea market on March 28th. Wayne ve7hm is once again at the helm of the flea market, full details for both events are on the webpage www3telus.net/ve7sar. The Weds Feb 4th 2009 regular meeting will be presented by Fred ve7io, Fred is going to talk to us about propagation. Fred is a BCPSN net control, he has attended Contest university at the Dayton Hamvention and is without doubt the #1 HF contester in our group so when he offers to share his knowledge on this or any subject with us we all should sit up and listen.

Hope to see you there.
Mike VE7AT

D-Star Presentation



Sol Lancashire, VA7SOL, took time out from his busy schedule to give a talk on D-Star to SARC members at the regular club meeting on Janu-

ary 7th 2009. The regular meeting venue at the PREOC was not available due to the recent flood watch so the meeting was held at the ABC restaurant in Newton. Sol explained how the D-Star re-

peaters are configured and how they are linked when in use. He covered the short-comings of the D-Star system as well as the many benefits of digital communications. One main benefit to digital is that most anything can be done providing the software is written to make it happen. Sol has written many software programs for D-Star and is without a doubt the most knowledgeable person in our area. Sol had many Power Point slides of some very technical areas for us to ask questions about.





There are two main D-Star repeaters in our area one is located on Seymour Mt. and is the old RAG repeater on 147.06 +, it is now a digital repeater and the other one is located at Central City on a tall commercial building it is VA7ICM and has excellent coverage all the way down to Seattle. Sol is the holder of the repeater licenses and maintains the website <http://www.va7icm.ca/> if you want complete information on our local repeater check out the website.

For those with D-Star radios there is a net on Sunday mornings at 0930 between Surrey and San Francisco. The net usually lasts about 1.5 hours and is a great place to pose your questions. I recently wanted to have my D-Star radio send my position report to APRS and struggled with the manual which was little help. I asked the question on the Sunday morning net and received some great tips on how to set up the IC 2820.

I am hoping that Sol will be available in the future as D-Star is constantly breaking new ground in communications.

On behalf of all the members of the Surrey ARC thanks to Sol for sharing his knowledge with us.

Some D-STAR information sites—
<http://www.warc.org.uk/clublinks.php>
<http://www.dstar.org/>
<http://www.warc.org.uk/clublinks.php>
<http://www.gb7sf.org.uk/>

Fred VE7IO



Norm McLeod VA7NDM

SK

Norm became a Silent Key on January 6th at 0500. Norm had been a member of SARC for several years but continually battled medical problems which prevented him from enjoying the club activities. Norm was an active ham and was on the air every day from his Ocean Park home where he had modest antennas and a new Yaesu FT 2000 transceiver. Norm always ran his amp at about 500 watts to overcome some of his antenna shortcomings and was a regular check-in on the BCPSN as well as the BC/Yukon Traffic Net. Norm also checked in regularly on the RV nets and was well known around North America.

He had a mobile radio, small amp and a Tarheel screwdriver antenna on his Buick and loved to travel to the interior and Vancouver Island. Norm was also a regular on our 3.725MHz morning gathering and enjoyed checking in while he was mobile. You could always recognize him when he checked as Victor Alfa Seven November Delta Mike.

I attended his celebration of life gathering on Monday January 12th where there were many of Norm's friends and family members. He was very active in the pipe band and in his younger days played the bagpipes and other instruments. At the gathering two pipers played Amazing Grace and it was very moving.

I will miss Norm as he lived close by and I always enjoyed visiting him and discussing ham radio.

Fred VE7IO

Sarc UHF repeater

The SARC UHF repeater is now on the air from South Surrey and has very good coverage over most of Surrey and into Burnaby, Langley, Richmond and Vancouver. The frequency is 443.775 MHz with a tone squelch of 110.9 meaning you need to set your CTCSS tone to 110.9 to access the repeater and if you like you can set your tone squelch to 110.9 to have your radio remain quite unless VE7RCS comes on the air.

In addition the repeater now offers an IRLP node allowing you to access a huge number of repeaters around the world. For complete information on IRLP check out this website <http://status.irlp.net/index.php?PSTART=5> Or <http://www.irlp.net/> you will find a huge amount of information which will allow you to have fun with IRLP.

The SARC UHF node number is 1463 and to drop the IRLP link use 73

Kjeld and Inge

Kjeld, VE7GP and his YL are heading south in their motorhome to find some warmer weather. They left on Saturday and will take their time heading to Southern Cal and Arizona. Kjeld has APRS with him and you can locate him using VE7GP-1

He is also on 3.725 MHz in the morning at 0730 PST and again at 2100 PST. He will also check into the RV net on 14.307.5 at 0900 PST but not Saturday and Sunday. He says he will also operate

PSK31 in the afternoon likely on 20 and 40 meters.

Ham Radio Humor

While traveling overseas, 3 guys were arrested and wrongfully convicted of being spies. They were sentenced to death in the electric chair. When the fateful day came, the first guy was placed in the electric chair and the executioner threw the big switch. Nothing happened. The judge said "this is an omen. You are free to go". The second guy was placed in the chair. Same results. The judge said "this too is an omen. You are free to go". The third guy, an extra class amateur was placed in the chair, and before the switch could be thrown to the Zap position he said "hey fellows, I'm a ham radio operator and if you will re-set the circuit breaker on that panel, I think this thing will probably work just fine"

Amateur Basic Class

The second basic amateur radio class offered by SARC will begin on Friday January 23rd. The classes will run for 8 weeks with the exam being held on the 9th week.

The dates are as follows -

1. Friday	January 23rd	1830 local time
2. Thursday	January 29th	1830 local time
3. Thursday	February 5th	1830 local time
4. Thursday	February 12th	TBA
5. Friday	February 20th	1830 local time
6. Thursday	February 26th	1830 local time
7. Thursday	March 5th	1830 local time
8. Thursday	March 12th	1830 local time
9. Thursday	March 19th	1830 local time
10. Thursday	March 26th	Examination

Please pass on this information to your friends and other clubs who may be interested in getting their ham license the last class had a 100% pass.

Instruction will be done by Gary Skett, VE7AS and Fred Orsetti VE7IO.

For complete information go to the SARC website at <http://www3.telus.net/ve7sar/>

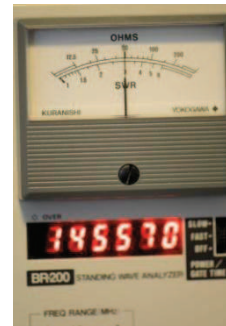


Aerial Adventures with Gary Skett, VE7AS

How did everyone do with their J-pole installation? Didn't everyone put their antenna up in sub-zero temperatures as the sun was setting and just before the snow began to fall?

I was very pleased with my end result. With 60 feet of LMR 240 my final VSWR

was 1.1:1 at 144.398 MHz. The 1.5:1 bandwidth was 147.992 to 140.957 and the impedance, measured at 145.570 and 146.974 MHz. was 50 ohms! How wonderful is that?



(Centre scale is 50 ohms →

Please let me know how your J-pole project turned out.

By request, in this installment we'll talk about **Standing Wave Ratio**.

Wikipedia defines Standing Wave Ratio (SWR) as the ratio of the amplitude of a partial standing wave at an antinode (maximum) to the amplitude at an adjacent node (minimum), in any transmission line.

The SWR is usually defined as a voltage ratio called the VSWR, for *voltage standing wave ratio*. For example, the VSWR value 1.2:1 denotes a maximum standing wave amplitude that is 1.2 times greater than the minimum standing wave value. It is also possible to define the SWR in terms of current, resulting in the ISWR, which has the same numerical value. The *power standing wave ratio* (PSWR) is defined as the square of the VSWR.

What's a standing wave? Luckily there are tons of examples in nature. Any stringed instrument such as a guitar or piano makes music using standing waves. But what about a traveling wave that reflects off of an object and creates a standing wave due to constructive interference? Let's go to the beach. Breakers roll in off the ocean, come up on the sand, and disappear; no standing wave occurs. What's happening? The beach is absorbing all (or at least most) of the energy, in effect it is "matched" to the wave front. Now let's go next door to marina where all of those expensive yachts are moored... chances are there are vertical concrete seawalls inside the marina to

allow owners to bring their boats close enough so that only a small walkway is needed to get to them. Now notice the breakwater that extends around the marina, with only a narrow opening for boats to go in and out. That's there because the vertical walls in the marina offer near perfect reflection to moving waves (an "open circuit"). Without the breakwater wall (which absorbs energy) huge standing waves are possible due to constructive interference, and all those boats would bob up and down like crazy corks and eventually everything would get smashed to tiny bits.

Let's look at it another way. As you press the PTT button or press the paddle on your Morse code key...ok...press the function key on your keyboard to send a "CQ" in PSK31, it gets transformed into RF energy and is sent zipping through the feed line to your antenna at a speed beyond human comprehension. Some of the RF has changed to heat because of losses in the feed line, but most arrives at the antenna.

Everything seems normal so far, but...all of a sudden you hear a sharp "CRACK!" and from your MFJ tuner an eerie, dense, foul smelling smoke escapes from the cracks and falls, like water off the table to the floor... Then your nose detects the acrid odour of burnt plastics as your spouse shrieks at you that your cable has developed "blisters" or worse, it's smouldering or has melted to the vinyl siding of your house....

Ok, a little extreme, but you get the picture. What's happened is a slight "disagreement" between your antenna, your feed line, your tuner and your transmitter. The disagreement comes in the form of an impedance mismatch. When the impedance of your antenna and your feed line are not the same, most of the energy is still radiated by the antenna, but the rest is reflected back to your radio. When reflected waves reach your radio, another odd thing happens; it's reflected right back to your antenna and some of it is radiated. The rest – you guessed it! – is reflected back to your radio. As microseconds turn to milliseconds, to seconds...your radio is still generating forward power which is combining with the reflected power. Without stepping knee deep in math – it's sufficient to say that these combinations of forward and reverse "waves" create standing waves. If you're running with your Kilowatt amp on...these standing waves, building harmonically or algebraically throughout your feed line and tuner, create "hot spots"...literally. Worse case – your feed line blisters, melts or bursts into flame...RF energy arcs between the plates of your variable capacitor or the coils of your inductors in your tuner....and it lets out the smoke...

When you insert your SWR meter in the line at your transceiver, it measures the result of this complex combination of waves and shows it as a function of forward and reflected power. That's why you get readings like 1.5:1 (1.5 to 1), 2:1, 3:1, 5:1, 10:1. Someone probably has already told you – "1:1 good..3:1 bad..10:1 Very Bad..."

The higher the ratio, the more power is reflected back to your radio. Common sense tells us that having any amount of reflective power is a bad thing – right? Well...it depends. It's certainly more of a problem [and obsession] to today's Hams than it was prior to WWII. In those days, Hams used open-wire feed lines. Because open lines were part of the radiating antenna element and the losses were extremely low, it wasn't much of a concern to most Hams.

The American war machine – responsible for a great deal of what we use today – like coaxial cable, better antennas, and a huge variety of connectors for all manner of cable types had flooded the market after the war and invaded Amateur Radio with a vengeance. Within a very short time it became the dominant feed line for the hobby and the radio industry in general.

Coax cable has a serious flaw however. Unlike open-wire line, many types of coax have significant loss. Air insulation was replaced with plastic and plastic isn't nearly as invisible to RF energy as air. Although significant advances in coaxial cable have been introduced in very recent history, you still have to spend BIG money and invest in air-insulated hard line before you have loss figures that rival open-wire lines. RF energy not able to radiate at the antenna [Loss] is reflected back to the transmitter and destined to end up heating up your cable or arcing across the plates of your tuning capacitor in your tuner [remember air has significantly less loss to RF than plastic.]

Is it OK to be a little obsessed with getting a good SWR? Well it's often silly to pursue the "perfect match" – 1:1 SWR. Rule of thumb....anything under 1.5:1 is good, 1.3:1 better – anything less is fantastic, but often only found in the laboratory under ideal operating conditions...Don't forget that commercial antenna designers know this obsession of ours and will use all manner of inductive and capacitive tricks to try and achieve the "Perfect Match." But does this antenna actually get you more DX contacts than one that has a 2:1 SWR?

Let's take a look at a few hypothetical examples and see what we have to gain or lose. The results were calculated using standard transmission line formulas.

Scenario 1: You've installed a 40-metre dipole and feeding it with 50 ohm RG-58 – 50 feet. Your SWR meter says you have a 1.5:1 ratio. In this example you are losing 0.62db in the total cable attenuation as a portion of your power travels back and forth. In reality a tiny fraction of your power is being lost. You would have to lose more than 1db before anyone would be able to hear the difference in your signal. So, if you trim and tweak our antenna to get it down to 1:1 SWR, you'll gain nothing except the satisfaction of seeing the result on your meter. (Your power loss will only drop from 0.62db to 0.57db)

Scenario 2: You're still using the 40-metre dipole with 50 feet of RG-58 but now you're trying to operate the antenna on 20 metres. The SWR meter reads an astonishing 67:1! Ok, most meters won't really display this high a measurement and most transceivers without antenna tuners would shut down. But just for argument's sake, this extremely high SWR represents a loss of 7db of the output. For 100 watts out, less than 25 watts would actually be radiated by the antenna.

Scenario 3: You are determined to use your 40-metre dipole on 20, so you replace the coax with 450 ohm ladder line. Because of the impedance is different for open-wire, the resulting SWR is only 7.5:1 instead of 67:1. It's still high, but the ladder line is low loss and this results in only 0.17db loss of your output power. With your antenna tuner in-line you can now use your antenna tuner with little difficulty – or loss.

Scenario 4: Let's head up to the 2-metre band. Here we have a beam antenna fed with 100 feet of RG-58 coax cable. Unfortunately something is wrong at the antenna and the SWR is 4:1. If you thought that RG-58 was lossy on the HF bands when the SWR was high, it's far worse at higher frequencies. A 4:1 SWR at 146 MHz. is about an 8.45 db loss [per 100 feet] . In other words, if your RF output was 25 watts, your antenna would see about 3 watts. And, you would not hear very well either. Don't forget it's not only transmitted signal loss, but receive signal attenuation as well.

In a situation like this, your SWR meter down in the shack can fool you about what's happening at the antenna. The loss in the feed line can hide a bad match [or a problem with the antenna], making it look much better than it really is. In this case, the SWR meter would show a 1.7:1 SWR – even though the SWR at the antennas is 4:1.

Scenario 5: We fixed the antenna and replaced the lossy RG-58 with a superior feed line (Belden 9913 or LMR400). The SWR at the antenna is now down to 1.5:1 and including the loss of 100 feet Belden 9913, the total loss is now only 1.68db. One of the reasons you should never run RG-58 at VHF or UHF!

What have we learned? All 5 examples have one thing in common: They suggest that power loss in feed lines is a function of type *and* length – *plus* the frequency *and* SWR – We knew that already....right? Or did you think your meter just measured an antenna's SWR? Makes you want to go Hummmmm?

Since all these 4 factors *act together*, it makes sense to measure the SWR at the antenna first, then [again] after you install your cable. So to get a good transfer of energy, the antenna must be “tuned” and your cable must be low loss and short as possible... New rule: High loss, High SWR BAD....Low loss, Low SWR GOOD. Man understand now....make better signals without smoke!

I just realized that I may have contradicted myself – or just corrected myself....I think I suggested, a few articles ago, that what kind of coax you use might not make that much of a difference? Well I think I just proved to myself – in writing this article – that you should indeed use the best, lowest loss cable that you can afford. In my case LMR240 for HF and LMR400 for VHF and LMR600 for UHF and higher....or just LMR400 for everything...darn...what do I do with my 1000ft. spool of LMR240 now? ☺

Remember what I said about the bouncing waves. The power that isn't lost in the feed line or at other points in the system has to go somewhere – out to your antenna! So when you think about the SWR reading on your meter, think carefully and take all the factors into account *before* you get out the ladder or hunt for your climbing belt.

When To Worry About SWR And When Not To Worry...

- ✓ ***Don't worry*** if you're feeding an HF antenna with 50Ω coax cable and the SWR is 3:1 or less. If the length of your feed line is under 100 feet, the difference between an SWR of 3:1 and 1:1 isn't worth your trouble. You could even run as high as 5:1 with LMR400/600 and suffer relatively little loss. If your radio is cutting back on its output because of an elevated SWR, insert a good antenna tuner to provide the 50Ω impedance it needs. If you're running over 500 watts output, achieving a lower SWR will be in your best interest as feed line, filter and antenna tuner damage may occur if you try and run too much power with an elevated SWR.
- ✓ ***Don't Worry*** if you're feeding an HF antenna with open-wire line and an antenna tuner. SWR has little meaning in this situation until you start seeing SWR of several *thousand* to one. Simply adjust the tuner for a 1:1 match at your transceiver and enjoy the QSO.
- ✓ ***Worry*** if you're operating at VHF or higher and the SWR is higher than 2:1 at the antenna. Even high-quality coax has substantial loss at these frequencies when the SWR starts creeping up. Adjust the antenna to bring it down to 2:1 or less. ***DO NOT USE*** a so-called VHF/UHF antenna tuner! The tuner will only provide a 1:1 SWR for your radio, but you're doing nothing to fix the unacceptable SWR at the antenna side of the tuner and that is where your losses are.
- ✓ ***Worry*** if the SWR on your antenna system changes substantially [up or down] for no apparent reason. Some fluctuation is normal, such as when ice or snow coats the antenna, the ground is very wet or very dry, or a flock of birds decide to rest on your entire antenna... Big changes are a warning – wind storm makes the SWR go from 1:1 to 10:1, for example. Check your meter too – cheap meters are unreliable and a waste of money – it's test gear, spend well when choosing a SWR/Power meter.

VSWR

VSWR

2.0

1.9

1.8

1.7

1.6

1.5

1.4

1.3

1.2

1.1

1.0

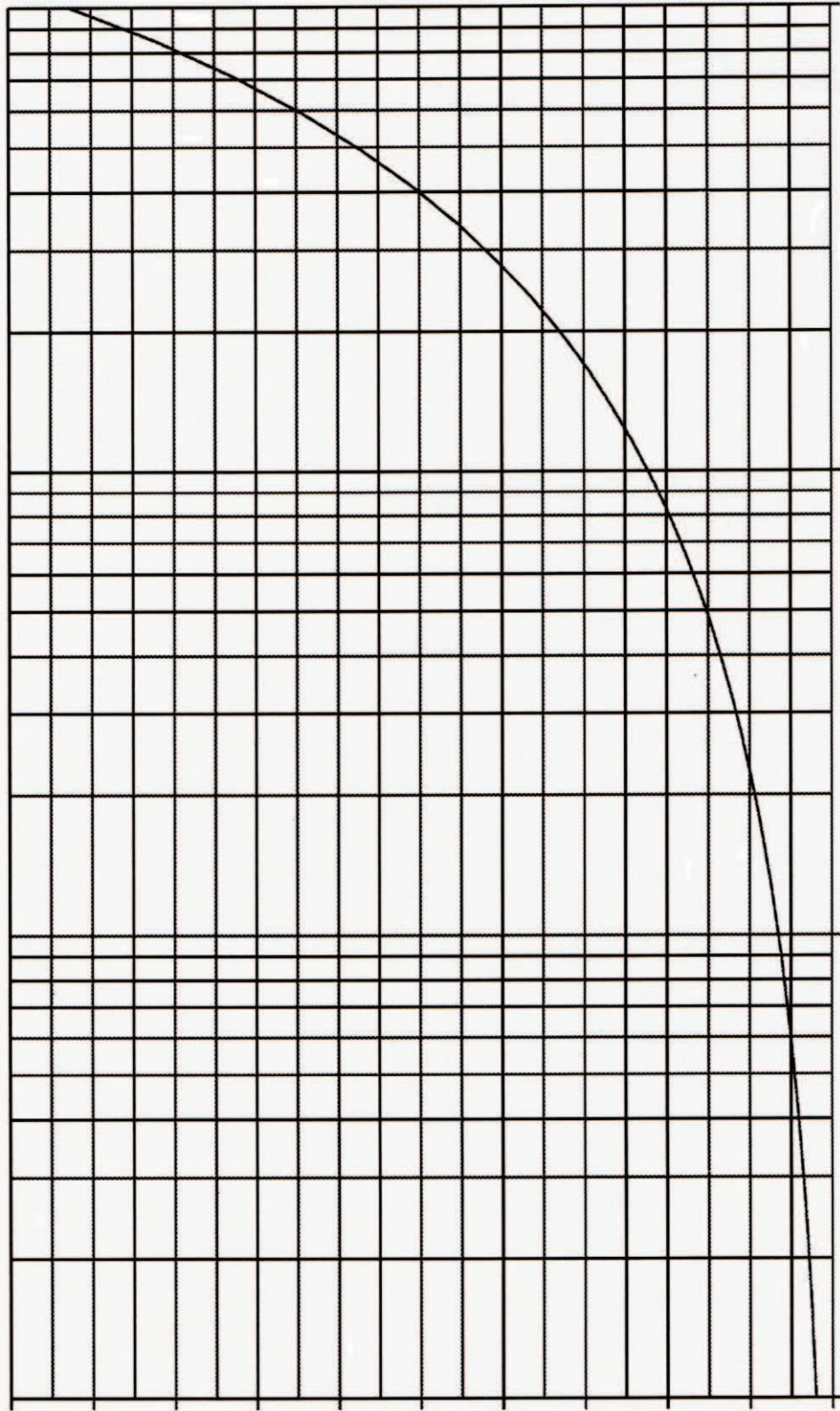
0.01%

0.1%

1%

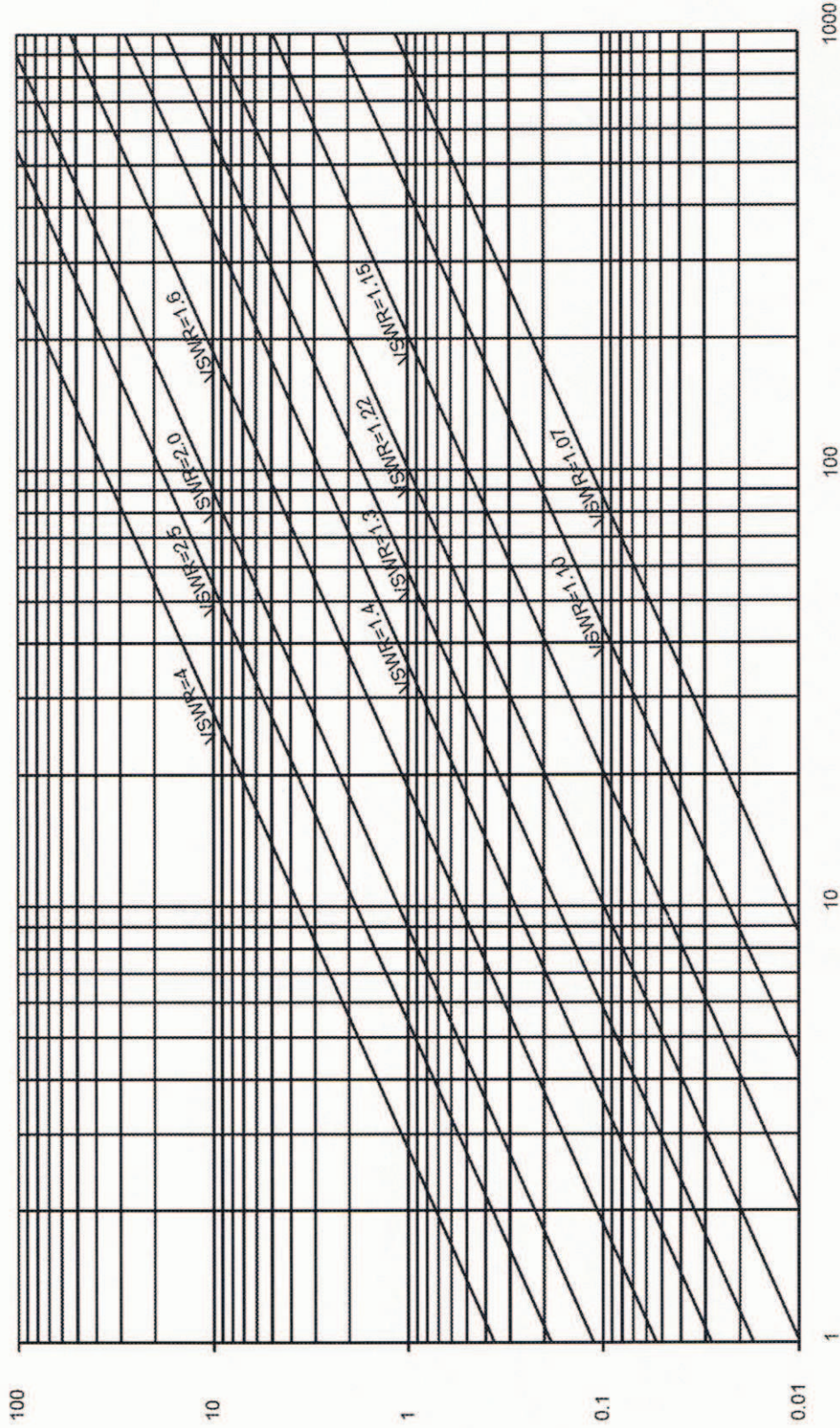
10%

Percent Reflected Power



VSWR Nomograph

Reflected Power



Forward Power

Get Out Your Calculators or Computers

"The Lure of the Ladder Line"¹ must have struck a responsive chord (or a nerve) out there—both Steve and I received many letters, telephone calls and Internet e-mail messages as soon as *QST* hit the streets in late December. Despite the snow and ice, some brave hams even went outside to change their feed lines from coax to ladder line. They excitedly reported that their signals were greatly improved—in fact, several just couldn't stop making happy noises to us!

There were some adverse reactions too, ranging from mild surprise to outright disbelief. Table 1 in the article caused the most shock—why should good-quality coax have so much loss? And why should even ladder line be so lossy at 1.8 MHz? Unfortunately, due to space limitations, a more detailed table of values had to be cut from the original article, leaving some of our more technically inclined brethren scratching their heads. So here are some details on how the loss figures were derived.

Just to spice things up a bit, this time I computed losses for a slightly different antenna—I used the same total amount of wire, 66 feet, but assumed that it was in the shape of a typical inverted-V, rather than a horizontal dipole.

I used *NEC2*, a mainframe computer program now available for use on high-end PCs, to analyze this antenna, rather than a *MININEC*-derived program. *MININEC* programs lose accuracy rapidly when the antenna is less than about 0.2 wavelength above ground. I specified "average" ground, having a conductivity of 5 mS/m (millisiemens per meter) and a dielectric constant of 13.

Once I had determined the feedpoint impedances for the multiband inverted V, I explored the feed-line loss for two types of transmission line—450-Ω "window" ladder line, which Steve had used for his antenna, and RG-213 type coax, which he had used before he discovered ladder line. In this illustration, each line was to be 100 feet long, a number I thought representative for a typical amateur installation (50 feet up the tree, 50 feet back to the shack).

By the way, this is a good point to digress just a bit. The wave mechanics in a transmission line can be a little mystifying to a novice (or even an old-timer like me). Books on transmission-line theory usually start out by analyzing a "theoretically perfect, lossless line." They look at such a line when it is matched, and then when it is mismatched. At this point they launch into detailed descriptions of forward and reflected waves, and all the complicated interactions they create. Sorry, but my eyes usually begin to glaze over by the second page.

There is a much simpler way to look at a practical (that is, lossy) transmission line that is not terminated in its characteristic impedance—at any point on that lossy line a unique impedance exists. If we insert an SWR meter (also called, more accurately, an *SWR bridge*) in the line, what we are measuring is the difference between the characteristic impedance of the line and the unique impedance at that point.

The value of the unique impedance at any one point on the line is determined by lots of factors—for the line itself, we have the characteristic impedance, physical length, velocity factor, and loss characteristics. Then we throw in the frequency and the terminating impedance (usually an antenna) at the end of the line. All these factors are elegantly and succinctly described by the Transmission Line Equation.²

¹ S. Ford, "The Lure of the Ladder Line," *QST*, Dec 1993, pp 70-71.

² The *ARRL Antenna Book*, 16th Edition, pp 27-29 to 27-30. See Eq 18.

NEW HAM COMPANION

We don't have enough room in this sidebar to get into the gory mathematical details, but we can let the personal computer simplify our lives. Some years ago I wrote a program called *TL*, short for *Transmission Line*, using this equation to compute the input impedance for any length of lossy transmission line, terminated in any desired impedance. *TL* is a versatile program and can compute other useful line parameters also. You can download *TL.EXE* by modem from the ARRL BBS by dialing 203-666-0578.

But back to our story—The feedpoint impedances generated by *NEC2* were used in *TL* to generate Table 1. There are several things worth noting in this table. First, the feedpoint impedance varies quite considerably with frequency for a multiband dipole. At 7.1 MHz, where the antenna is nominally resonant, the SWR on a 50-Ω coax is a reasonable 2 to 1, but that same coax would see a phenomenally high 63,761 to 1 SWR at 1.83 MHz, where the 40-meter antenna is only an eighth-wave long! Due to the extremely high SWR at 1.83 MHz, the loss in 100 feet of RG-213 coax is 32.5 dB. If 100 W were fed into this line, only 0.06 W would appear at the antenna end. That's right—60 milliwatts—instant QRP!

When trying to feed an extremely short antenna like this at 1.83 MHz, even low-loss 450-Ω ladder line would see a huge SWR of 7,355 to 1. Ladder line loses 11.2 dB, even though the matched-line loss at this frequency is a miniscule 0.01 dB per 100 feet. Another very nasty thing makes its presence known when extremely high SWRs are encountered for 1500 W of power at 1.83 MHz, *TL* computes that the maximum RF rms voltage is almost 40,000 V! That will fry most antenna tuners, or at least cause them to arc over internally. Steve was not kidding when he stated that his kW antenna tuner was not a happy camper on 160 meters, even when he had backed the power down to less than 20 W!

So the moral of this tale is simple—as versatile as multiband dipoles may be, especially to a ham who can't put up separate antennas for all the HF bands, they do have limitations. If they are electrically very short, for example on 160 meters, there will be losses in whatever transmission line feeds it. Using coax cable to feed a simple multiband antenna will result in far greater losses than for open-wire feeders, on all frequencies.—N6BV

Table 1

Inverted-V Dipole, 50 feet high, 66 feet long, fed with 100 feet of 450-Ω "window" ladder line, or 100 feet of RG-213 coax.

Frequency (MHz)	Antenna feedpoint impedance	SWR for ladder line	Total loss (in dB) for ladder line	SWR for RG-213	Total loss (in dB) for RG-213
1.83	1.6 - j2256.6	7355	11.2	63761	32.5
3.80	10.3 - j878.8	210	2.2	1505	18.1
7.10	64.8 - j40.6	7	0.2	2	0.7
10.10	21.6 + j648.4	64	1.8	392	14.9
14.10	5287.1 - j1309.5	13	0.5	112	9.7
18.10	198.2 - j819.9	10	0.6	72	9.4
21.20	102.9 - j181.2	5	0.3	9	3.2
24.90	269.3 + j569.6	5	0.4	30	6.9
28.40	3088.9 + j774.0	7	0.6	66	10.1